

REMARKS

Applicants respectfully request reconsideration and withdrawal of the outstanding Office Action rejections based on the foregoing amendments and following remarks.

Claim 14 has been amended to correct a translational error, which removes the term "compensate" from claim 14 and replaces it with the term "cancel." Support for this amendment can be found in the present specification at page 5, line 25 – page 6, line 11.

Claim 17 has been amended to clarify the claim language and to place claim 17 in better condition for examination. No new matter has been added.

The Examiner has objected to the drawings because the Examiner contends that Figure 4 does not show the appropriate band structure of the quantum dots. Applicant respectfully submits that Figure 4 shows a single period of a quantum cascade laser structure, which contains a number of quantum wells separated from each other by barrier layers. The photon emission of the laser takes place when an electron changes energy level in the quantum well layer 301C after tunnelling into said quantum well layer 301C from quantum well layer 301 D through the barrier layer 303D. Barrier layer 303D contains the quantum dots 310. However, the quantum dots 310 do not provide any energy levels used by the electron. The only meaning of the quantum dots 310 is to cancel or modulate a translational symmetry of the barrier layer 303D so as to allow for normal emission of the photon in the quantum well layer 301C. Hence, the band structure of the quantum dots is not relevant, or necessary, for describing the single period of a quantum cascade laser structure. It is, therefore, believed that it is not necessary to show the band-structure of the quantum dots in Figure 4. Accordingly, Applicant respectfully request reconsideration and withdrawal of this objection.

Claims 14-26 stand rejected under 35 U.S.C. 112, second paragraph, as being allegedly indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

The Examiner contends that claims 14 and 23 are indefinite because it is unclear which direction is the lateral direction. In response to this contention, Applicant respectfully points the Examiner to paragraphs 0017, 0018, 0031, 0035 and 0042-0044 of the present specification, whereby Applicant contents it is explicitly defined therein what is meant by the lateral direction. Applicant further contends that one of ordinary skill in the quantum well arts would easily recognize and appreciate what is meant by the lateral direction such that no further limitations would be needed in either of claim 14 or claim 23.

The Examiner contends that claim 17 is indefinite because it is unclear what constitutes "markedly greater." In response to this contention, Applicant has amended claim 17 to remove "markedly" from claim 17 such that claim 17 now recites "...are made from a material which has a greater lattice constant than the material of the barrier layer...." Accordingly, Applicant respectfully requests reconsideration and withdrawal the rejections under 35 U.S.C. 112, second paragraph.

Claims 14-25 stand rejected under 35 U.S.C. 102(b) as being allegedly anticipated by Holonyak (US Published Patent Application No. 2003/0059998). The Examiner contends that Holonyak discloses each and every element of present claims 14-25. More specifically, the Examiner contents that Holonyak discloses a quantum well structure for the absorption or emission of photons comprising a quantum well layer arranged between two barrier layers, wherein at least one of the barrier layers

comprises nanostructures which compensate or modulate a lateral homogeneity of the barrier layer which is present without the nanostructures wherein the quantum well layer is the absorption or emission layer. Applicant respectfully disagrees with the Examiner's contention for at least the following reasons.

Holonyak discloses quantum dots that are separated from a quantum well by a barrier layer having a thickness of between 5 and 100 Angstroms (see paragraph [0013]). From at least paragraph [0013], it can be deduced that the quantum dot layer of Holonyak is not a barrier layer or part of a barrier layer, but is adjacent to a barrier layer. Moreover, Figure 9 of Holonyak shows that the conduction band edge of the quantum dots is lower than the conduction band edge of the quantum well. Hence, the quantum dot layer of Holonyak can not be a barrier layer or comprise a portion of the barrier layer. Present claim 14, the sole pending independent claim, requires nanostructures, or quantum dots, that comprise at least a portion of a barrier layer.

Furthermore, Holonyak also discloses that the purpose of the quantum dots is to use their high density of states to capture electrons and holes to feed into the quantum well, coupled to the quantum dot layer via tunnelling through the barrier. Thus, the quantum dot layer is NOT part of the barrier layer. In contrary thereto, the quantum dots required by present claim 14 are part of the barrier layer and are used to break the translational symmetry, thus allowing photons with electric-field vector perpendicular to the surface to couple to intersubband transitions. For at least the aforementioned reasons, Applicant respectfully submits that Holonyak does not and can not anticipate each and every element of present claim 14. Moreover, since claims 15-25 are dependent upon claim 14, either directly or indirectly, Applicant respectfully submits that

Holonyak does not and can not anticipate each and every element of present claims 15-25. Accordingly, Applicant respectfully requests reconsideration and withdrawal of the outstanding 35 U.S.C. 102(b) rejection.

Claim 26 stands rejected under 35 U.S.C. 103(a) as being allegedly unpatentable over Faist (*IEEE J. of Quantum Electronics*, v. 38, No. 6, June 2002, pages 533-546) in view of Holonyak (US Published Patent Application No. 2003/0059998). The Examiner contends that Faist teaches a quantum well cascade laser, but does not teach the quantum well structure of present claim 14. The Examiner relies on Holonyak for a disclosure of using quantum dots as a source of carriers. The Applicant respectfully disagrees with the Examiner's contention and submit that the Examiner has not established a *prima facie* case of obviousness for at least the following reasons.

As outlined above, Holonyak does not and can not anticipate each and every element of present claim 14 because Holonyak does not disclose nanostructures, or quantum dots, that comprise at least a portion of a barrier layer. Therefore, the combination of Faist and Holonyak would lead to a quantum cascade laser (from Faist) that comprises a quantum well structure having a barrier layer that did not comprise nanostructures, or quantum dots (from Holonyak). Furthermore, there is no teaching or disclosure in either of Faist or Holonyak for a quantum well structure having a barrier layer that comprises nanostructures or quantum dots that would lead one of ordinary skill in the art who considered the disclosures of Faist and Holonyak, either alone or in combination with one another, to arrive at a quantum cascade laser having a quantum well structure having a barrier layer that comprises nanostructures or quantum dots. Thus, Applicant submits that the disclosure of Holonyak does not cure the noted

deficiencies of Faist or vice versa. Accordingly, Applicant respectfully requests reconsideration and withdrawal of the outstanding 35 U.S.C. 103(a) rejection.

In view of the foregoing amendments and remarks, Applicants respectfully request withdrawal of the outstanding Office Action rejections. Early and favorable action is awaited. The Director is authorized to charge any fees or overpayment to Deposit Account No. 02-2135.

Respectfully submitted,

By


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